

CLAIMS

1. A carbon material for a battery electrode, which
5 comprises a carbon powder material as a composite of
carbonaceous particles and an a carbon material derived from
an organic compound prepared by allowing the organic compound
serving as a polymer source material to deposit onto and/or
permeate into the carbonaceous particles to thereby
10 polymerize the polymer material and then heating at 1,800 to
3,300°C, and which has an intensity ratio of 0.1 or more for
peak intensity attributed to a (110) plane to peak intensity
attributed to a (004) plane determined through X-ray
diffraction spectroscopic analysis on a mixture of the carbon
15 material and a binder resin when pressed at 10^3 kg/cm² or
higher.

2. The carbon material for a battery electrode as
claimed in claim 1, wherein the carbonaceous particles are
20 composed of natural graphite, petroleum-derived pitch coke or
coal-derived pitch coke.

3. The carbon material for a battery electrode as
claimed in claim 1, wherein the carbonaceous particles are
25 composed of high-crystallinity natural graphite which has the
C₀ value of a (002) plane as determined through X-ray
diffraction spectroscopy of 0.6703 to 0.6800 nm, La
(crystallite size in the a-axis direction) of greater than
100 nm (La > 100 nm) and Lc (crystallite size in the c-axis
30 direction) of greater than 100 nm (Lc > 100 nm).

4. The carbon material for a battery electrode as claimed in claim 1, wherein the carbonaceous particles have a laser diffraction mean particle size of 10 to 40 μm .

5 5. The carbon material for a battery electrode as claimed in claim 1, wherein a mean roundness of the carbonaceous particles as measured by use of a flow particle image analyzer is 0.85 to 0.99.

10 6. The carbon material for a battery electrode as claimed in claim 1, wherein the laser Raman R value of the carbonaceous particles (the ratio of a peak intensity at $1,360\text{ cm}^{-1}$ to a peak intensity at $1,580\text{ cm}^{-1}$ in the laser Raman spectrum) is 0.01 to 0.9.

15 7. The carbon material for a battery electrode as claimed in claim 1, wherein the area ratio of a region including a diffraction pattern having two or more spots to a region including only one spot attributed to a (002) plane is
20 95 to 50 : 5 to 50 in a $5\text{ }\mu\text{m}$ square region arbitrarily selected from a transmission electron microscope bright field image of a cross-section surface obtained by cutting the carbonaceous particles into flake form.

25 8. The carbon material for a battery electrode as claimed in claim 1, wherein the carbon material derived from an organic compound is a graphitized material.

9. The carbon material for a battery electrode as
30 claimed in claim 1, wherein the carbon material derived from an organic compound is contained in an amount of 2 to 200

parts by mass based on 100 parts by mass of carbonaceous particles serving as a core material.

10. The carbon material for a battery electrode as
5 claimed in claim 1, wherein graphite crystalline structure regions and amorphous structure regions are dispersed from the surface to the center in each of the particles constituting the carbon material.

10 11. The carbon material for a battery electrode as claimed in claim 1, wherein the area ratio of a region including a diffraction pattern having two or more spots to a region including only one spot attributed to a (002) plane is 99 to 30 : 1 to 70 in a 5 μm square region arbitrarily
15 selected from a transmission electron microscope bright field image of a cross-section surface obtained by cutting the carbon material for a battery electrode into flake form.

12. The carbon material for a battery electrode as
20 claimed in claim 1, which contains boron in an amount of 10 ppm to 5,000 ppm.

13. The carbon material for a battery electrode as
claimed in claim 1, which contains carbon fiber having a
25 fiber diameter of 2 to 1,000 nm.

14. The carbon material for a battery electrode as
claimed in claim 13, wherein at least portion of the carbon
fiber is deposited on a surface of the carbon powder material.

30 15. The carbon material for a battery electrode as

claimed in claim 13, which contains carbon fiber in an amount of 0.01 to 20 parts by mass based on 100 parts by mass of the carbon powder material.

5 16. The carbon material for a battery electrode as claimed in claim 13, wherein the carbon fiber is a vapor grown carbon fiber having an aspect ratio of 10 to 15,000.

10 17. The carbon material for a battery electrode as claimed in claim 16, wherein the vapor grown carbon fiber is a graphite carbon fiber which has undergone heat treatment at 2,000°C or higher.

15 18. The carbon material for a battery electrode as claimed in claim 16, wherein the vapor grown carbon fiber has, in its interior, a hollow structure.

20 19. The carbon material for a battery electrode as claimed in claim 16, wherein the vapor grown carbon fiber contains a branched carbon fiber.

25 20. The carbon material for a battery electrode as claimed in claim 16, wherein the vapor grown carbon fiber has a mean interlayer spacing (d_{002}) of a (002) plane of 0.344 nm or less as measured by means of X-ray diffractometry.

30 21. The carbon material for a battery electrode as claimed in claim 1, wherein the carbon powder material satisfies at least one of the following requirements:
(1) mean roundness as measured by use of a flow particle image analyzer is 0.85 to 0.99;

(2) C_0 value of a (002) plane as measured by means of X-ray diffractometry is 0.6703 to 0.6800 nm, L_a (crystallite size in the a-axis direction) is greater than 100 nm ($L_a > 100\text{nm}$), and L_c (crystallite size in the c-axis direction) is greater than 100 nm ($L_c > 100\text{nm}$), ;

(3) BET specific surface area is 0.2 to 5 m^2/g ;

(4) true density is 2.21 to 2.23 g/cm^3 ;

(5) laser Raman R value (the ratio of a peak intensity at 1,360 cm^{-1} in a laser Raman spectrum to a peak intensity at 1,580 cm^{-1} in the spectrum) is 0.01 to 0.9; and

(6) mean particle size as measured through laser diffractometry is 10 to 40 μm .

22. The carbon material for a battery electrode as claimed in claim 1, which has an initial discharge capacity of 340 mAh/g or higher.

23. A method for producing a carbon material for a battery electrode which is a carbon powder material as a composite of carbonaceous particles and an a carbon material derived from an organic compound and has an intensity ratio of 0.1 or more for peak intensity attributed to a (110) plane to peak intensity attributed to a (004) plane determined through X-ray diffraction spectroscopic analysis on a mixture of the carbon material and a binder resin when pressed at $10^3 \text{ kg}/\text{cm}^2$ or higher, comprising a step of allowing the organic compound or a solution thereof serving as a polymer source material to deposit onto and/or permeate into the carbonaceous particles, a step of polymerizing the organic compound and a step of heating the obtained particles at 1,800 to 3,300°C to thereby graphitize and/or carbonize the

particles.

24. The method for producing a carbon material for a battery electrode as claimed in claim 23, wherein the step of polymerizing the organic compound includes heat treatment at 100 to 500°C, and the step of carbonizing and/or graphitizing the particles includes heat treatment at 2,300°C to 3,300°C.

25. The method for producing a carbon material for a battery electrode as claimed in claim 23, wherein the carbonaceous particles are natural graphite particles.

26. A method for producing a carbon material for a battery electrode which is a carbon powder material as a composite of carbonaceous particles and an a carbon material derived from an organic compound and carbon fiber having a filament diameter of 2 to 1,000 nm with at least portion of carbon fiber depositing on the carbonaceous particles and has an intensity ratio of 0.1 or more for peak intensity attributed to a (110) plane to peak intensity attributed to a (004) plane determined through X-ray diffraction spectroscopic analysis on a mixture of the carbon material and a binder resin when pressed at 10^3 kg/cm² or higher, comprising a step of treating carbonaceous particles with a mixture or solution containing the organic compound serving as a polymer source material and carbon fiber having a filament diameter of 2 to 1,000 nm to thereby allow the organic compound to deposit onto and/or permeate into the carbonaceous particles and allow the carbon fiber to deposit onto the particles, a step of polymerizing the organic compound and a step of heating the obtained particles at

1,800 to 3,300°C.

27. A carbon material for a battery electrode, which is produced through a method for producing a carbon material for a battery electrode as recited any of claims 23 to 26.

28. A paste for producing an electrode, which comprises a carbon material for a battery electrode as recited any one of claims 1 to 22 and 27, and a binder.

29. An electrode formed of a compact of a paste as recited in claim 28.

30. The electrode as claimed in claim 29, wherein the ratio of peak intensity attributed to a (110) plane to that attributed to a (004) plane is 0.1 or more as determined through X-ray diffraction spectroscopic analysis on the compact.

31. A battery comprising as a constituent an electrode as recited in claim 29.

32. A secondary battery comprising as a constituent an electrode as recited in claim 29.

33. A secondary battery as claimed in claim 32, wherein the battery employs a non-aqueous electrolytic solution and/or a non-aqueous polymer electrolyte, and the non-aqueous electrolytic solution and/or the non-aqueous polymer electrolyte contains a non-aqueous solvent which is at least one species selected from the group consisting of ethylene

carbonate, diethyl carbonate, dimethyl carbonate, methyl ethyl carbonate, propylene carbonate, butylene carbonate, and vinylene carbonate.

5 34. A method for evaluating a carbon material for a battery electrode containing a composite carbon powder material of carbonaceous particles and an carbon material derived from an organic compound which is produced by allowing the organic compound serving as a polymer source
10 material to deposit onto and/or permeate into to carbonaceous particles serving as a core material, thereby polymerizing the organic compound, and then calcining the obtained particles at 1,800 to 3,300°C, wherein the evaluation employs as an index, a ratio (0.1) of peak
15 intensity attributed to a (110) plane to that attributed to a (004) plane determined through X-ray diffraction spectroscopic analysis on a mixture of the carbon material and a binder resin when pressed at 10^3 kg/cm² or higher.